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3:00

DOPPLER FLOW MAPPING CAN MEASURE VASCULAR FLOW PROFILES: INITIAL OBSERVATIONS AND IN VITRO VALIDATION

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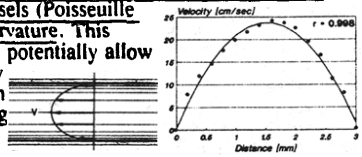
The ability to measure velocity profiles across vessels could increase our understanding of the effect of vascular geometry on flow and its relation to the development of vascular disease. Color Doppler flow mapping (CDFM) could potentially provide such profiles conveniently without intravascular probes that may alter flow. First, however, it must be shown that CDFM can reproduce known velocity profiles. We therefore addressed the hypothesis that quantitative CDFM can reproduce a standard velocity profile (fully-developed parabolic flow) and the behavior of flow at a curve. Smooth linear vessels 3 mm in diameter were steadily perfused with blood and imaged with a 7 MHz linear-array transducer beyond the entrance length for parabolic flow development. Angle-corrected velocities were digitally extracted from the flow map and profiles averaged at several sites. Flow at a smooth curve was also examined, and observations made in the coronary arteries of 6 open-chest dogs. **RESULTS:** 1) The Doppler-derived velocity profiles in straight vessels correlated well with the expected parabolic form (r=.99). 2) At a curve, the profile became skewed, with highest velocities near the outer wall as predicted. 3) Coronary studies showed high central velocities with variable profiles as expected for pulsatile, branching flow. **CONCLUSION:** CDFM can reproduce standard parabolic flow profiles across straight vessels (Poisseuille flow) and the effects of curvature. This technique should therefore potentially allow us to explore vascular flow patterns quantitatively with the ultimate aim of relating them to the development of vascular disease.

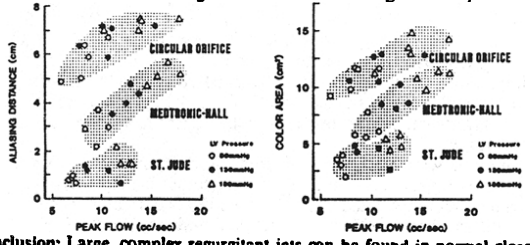


3:15

COLOR DOPPLER REGURGITANT CHARACTERISTICS OF MECHANICAL VALVES IN VITRO

Helmut Baumgartner, Steven S Khan, Michele A DeRobertis, Lawrence SC Czer, Gerald Maurer. Cedars-Sinai Medical Center, Los Angeles, CA.

To evaluate normal regurgitant characteristics of St. Jude (SJ) and Medtronic-Hall (MH) mitral valves, 4 sizes (25-31mm) of each were studied in a pulsatile flow model. Regurgitant flow was measured by flowmeter at LV pressures of 80-180mmHg. Regurgitant orifice areas (RO) calculated with the continuity equation ranged from 1.6 to 2.0mm^2 in SJ and 2.2 to 2.9mm^2 in MH. Regurgitant volumes (RV) normalized to an ejection time of 280msec ranged from 1.4 to 1.8cc in SJ and 2.0 to 2.5cc in MH valves. Jets were imaged by color Doppler in 6 rotational planes and compared to circular orifices (CO) with sizes comparable to the calculated prosthetic valve RO (1.1-3.1 mm2). SJ valves showed two converging jets from the pivot points, one central jet, and small peripheral jets; aliasing was only seen close to the valve. MH showed a large aliased central jet and small peripheral jets without aliasing. The CO had a single jet with aliasing up to 7.3 cm. At similar regurgitant orifice areas, driving pressures, and regurgitant flows, the measured color areas and aliasing distances were smallest in SJ valves, larger in MH valves and largest in simple CO.



Conclusion: Large, complex regurgitant jets can be found in normal closed SJ and MH valves by color Doppler, although regurgitant flow is minimal. Jet size, velocity distribution, and aliasing distance differ markedly in SJ, MH, and CO, even with identical regurgitant orifice areas, pressures, and regurgitant volumes.

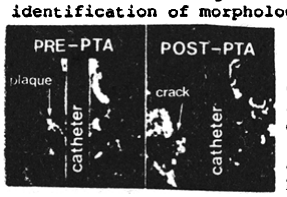
Tuesday, March 5, 1991
2:00PM–3:30PM, Room 366, West Concourse
Intravascular Ultrasound Imaging During Angioplasty

2:00

ON-LINE 3-D RECONSTRUCTION OF 2-D INTRAVASCULAR ULTRASOUND IMAGES DURING BALLOON ANGIOPLASTY: CLINICAL APPLICATION IN PATIENTS UNDERGOING PERCUTANEOUS BALLOON ANGIOPLASTY

Kenneth Rosenfield, Douglas W. Losordo, Paul Palefski, R. Eugene Langevin, Jr., Syed Razvi, Daria Majzoubi, Jeffrey M. Isner, Tufts University School of Medicine, St. Elizabeth's Hospital, Boston, MA

Computer-based 3-dimensional reconstruction (3DR) transforms 2-D intravascular ultrasound (IVUS) images into a composite longitudinal format more familiar to the angiographer, and thus facilitates analysis of luminal narrowing and defects in the vessel wall. To explore the feasibility of rapid on-line 3DR, we performed 3DR on 33 vascular segments (length 2-10 cm(m=5)) pre- and post-iliac balloon angioplasty (BA) in 4 pts. During systematic, 20-sec timed pullback through each segment of vessel, 60 live IVUS images were acquired at 3 frames/sec. Immediate, on-line analog to digital conversion and 3DR generated longitudinal sagittal views within 78 to 100 seconds (m=91). Timely 3DR display of up to 30 distinct, high-resolution orthogonal views facilitated rapid identification of morphologic abnormalities and residual stenoses. In 3 cases, 3DR indicated the need for repeat dilatation, confirmed angiographically and by residual pressure gradient.. Conclusion: 1) 3DR of 2D IVUS images obtained pre- and post-BA can be accomplished on-line (≤100 sec), potentially extending the utility of IVUS during interventional procedures; 2) rapid 3DR may facilitate analysis of stenoses by providing unlimited orthogonal projections of vessel without use of contrast.



2:15

INTRAVASCULAR ULTRASOUND DETECTS PLAQUE PROGRESSION EARLIER AND MORE ACCURATELY THAN QUANTITATIVE ANGIOGRAPHY

John E. Lassetter, Robert C. Krall, David S. Moddrelle, and Ronald D. Jenkins, University of Utah School of Medicine, Salt Lake City, Utah.

To test the hypothesis that intravascular ultrasound (US) provides a more accurate assessment of the onset and progression of atherosclerotic plaque as compared to quantitative angiography (ANGIO), US and ANGIO measurements of luminal cross-sectional area (LCSA) and diameter (D) of two sites in the distal aorta were compared in 33 New Zealand White rabbits on an atherogenic diet (mean serum cholesterol=1448). US measurements of arterial wall cross-sectional area (WCSA) and thickness (T) were also obtained. Fifteen of the rabbits had repeat ANGIO and US evaluations at intervals up to 12 weeks following Fogarty balloon endothelial denudation at the test sites to stimulate atherogenesis.

US and ANGIO derived measurements of D and LCSA were similar (mean ANGIO D = 3.76 ±.44mm vs. mean US D =3.77 ±.46mm, r^2=.84; mean ANGIO LCSA = 11.22 ±2.62mm^2 vs. mean US LCSA =11.20 ±2.65mm2. r^2=.86).

	INTERVAL POST BALLOON INJURY (weeks)				
CHANGE	0-1	2-4	5-7	8-10	≥11
D (mm)	-.37	-.71	-.47	-.58	-.72
LCSA (mm^2)	-2.2	-4.3	-2.8	-3.3	-3.5
T(mm)	+.02	+.09	+.18	+.35	+.35
WCSA (mm^2)	-.13	+.37	+1.2	+2.3	+2.9

ANGIO luminal measurements showed initial decrement following balloon injury, without further evidence of plaque formation. In contrast, US measurements of WCSA and T demonstrated incremental plaque progression, suggested at 2 weeks(p<.1),and clearly present as early as 5 weeks (p<.05). Therefore, US measurements of the arterial wall, which are less affected by changes in vascular tone, appear to detect the onset and progression of neointimal thickening more accurately than angiography.